RISK BASED ANALYSIS

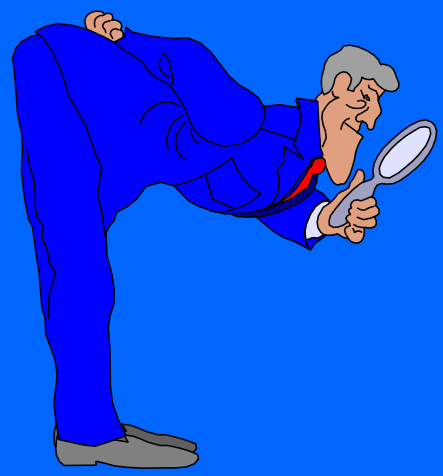
OBJECTIVES

- **Describe risk-based analysis**
- **Provide an overview of Corps activities in RBA**
- **Flood control application**

RISK BASED ANALYSIS

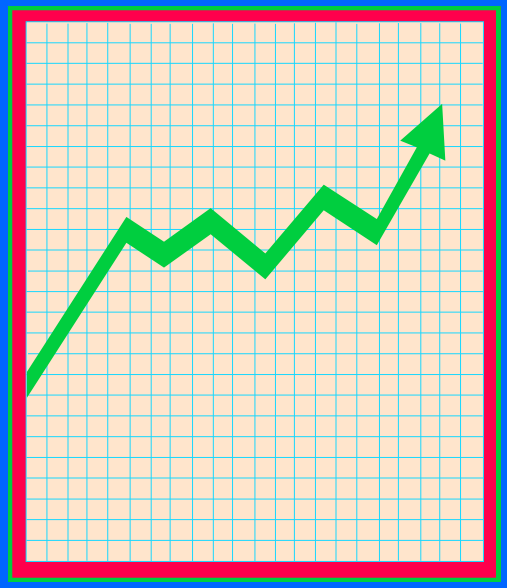
"Planners shall identify areas of risk and uncertainty in their analysis and describe them clearly, so that decisions can be made with knowledge of the degree of reliability of the estimated benefits and costs and of the effectiveness of alternative plans."

P&G, Par. 10, Feb 83



RISK BASED ANALYSIS

An approach to evaluation and decision making that explicitly, and to the extent practical, analytically incorporate considerations of risk and uncertainty.



WHY NOT DO RISK BASED ANALYSIS?

" Therefore, while a _____ project may be operating as planned and designed, other important factors outside the control of the _____ measure will also play a critical role in achieving the desired goal of the project. For these reasons, a risk and uncertainty analysis for _____ was not performed."

BASIC CONCEPTS

- **RISK**
- **UNCERTAINTY**
- **PROBABILITY DENSITY FUNCTION, PDF**
- **CENTRAL VALUE STATISTICS**
- **DISPERSION STATISTICS**
- **MONTE CARLO SIMULATION**

RISK

- **Determined by occurrence probability of an event.**
- **Magnitude = 0 to 1**
- **Examples:**
  - Probability of being flooded
  - Probability of unsatisfactory performance

UNCERTAINTY

- **True value of variables not known.**
- **Values can take on a range.**
- **Leads to errors in estimates.**

PROBABILITY DISTRIBUTION FUNCTION (PDF)

Defines probability of occurrence of a particular random variable.

Random variable - outcome or value can not be predicted before event takes place.

Parameters that define distribution are derived from sample data.

CENTRAL VALUE STATISTICS

- **MODE = Most frequent value**
- **MEDIAN = Middle of ranked list**
- **MEAN = Sum of values divided by number of values**

DISPERSION STATISTICS

- **Standard deviation = average deviation from the mean**
- **Variance = standard deviation squared**

MONTE CARLO SIMULATION

- **Numerical integration technique to approximately derive the distribution of a random variable (Q), given:**
  - The behavior of variable (Q) is determined from contributing variables X, Y and Z
  - A function or relationship giving the value of (Q) knowing the values of X, Y and Z
  - The probability distributions of X, Y and Z

EXAMPLE

- **Flood Control Study:**

  Q = Stage-Damage Curve

  X = Stage-Discharge Curve
  Y = First Floor Elevation
  Z = Structure Values

OVERVIEW OF CORPS RBA

RISK BASED ANALYSIS

- **Major Rehabilitation Studies**
- **Flood Control**
- **Deep Draft Navigation**
- **Ecosystem Restoration**
- **Storm Damage Prevention**

MAJOR REHAB STUDIES

1/5/99

INLAND NAVIGATION AND HYDROPOWER

GUIDANCE: EP 1130-2-500

Project Operations, Partners and Support (Work Management Guidance and Procedures)

1/5/99

INLAND NAVIGATION AND HYDROPOWER

- **Studies funded under O&M**
- **Construction funded under CG Appropriations**
- **Must compete for new start funding**

QUESTIONS

- **To rehab or not to rehab?**
- **Is rehab really needed now?**
- **What is the best rehab option?**
- **Will future losses offset investment?**

HYDROPOWER

- **Reliability**
  - Restore units back to original design

- **Efficiency Improvements**
  - Production over original design condition

1/5/99

INLAND NAVIGATION

- **Commodity forecasts**
- **Unplanned closures-delays**
- **System Capacity**
- **Fleet characteristics**
- **Foundation conditions**
- **Cross-currents**
- **Filling rates**
- **Climatic conditions**
- **Environmental windows**
- **Competing uses**
- **High/Low flows**

DEEP DRAFT NAVIGATION

- **NED Costs:**
  - Channel Dimension
  - Maintenance
  - Shoaling/Sedimentation
  - Cost of dredging
- **NED Benefits:**
  - Vessel Traffic
  - Fleet Forecast
  - Commodity Forecast
  - Vessel Operations

DEEP DRAFT NAVIGATION

- **Others:**
  - Vessel Safety
    - Underkeel Clearance
    - Passing Clearance
  - Environmental Risks

STORM DAMAGE PREVENTION

- **Wave Height Frequency**
- **Stage Frequency**
- **Erosion**
- **Duration**
- **Stage-damage Relationship**
- **Direct wave damage**
- **Undermining damage**
- **Long term erosion**

STORM DAMAGE PREVENTION

- **Model:**
  - Developed by Wilmington District
  - Life Cycle Analysis
  - Monte Carlo Simulations

ECOSYSTEM RESTORATION

- **Not EPA's Ecological Risk Assessment**
- **R&U in environmental outputs using HEP**

SOURCES OF UNCERTAINTY

- **Delineation of study area**
- **Target Species**
- **Habitat Suitability Index Models (HSI)**
- **Habitat Variable Measurements**
- **Habitat Unit Estimates**
- **Changes in Habitat Units**
- **Project Performance**

FLOOD CONTROL

GUIDANCE: ER 1105-2-101

Risk based analysis for evaluation of hydrology/hydraulics, geotechnical stability and economics in flood damage reduction studies

HIGHLIGHTS

- **RBA required for all type of studies.**
- **PSP will describe methods to quantify uncertainty of key variables.**
- **NED still rules.**
- **No more “freeboard”.**
- **No more “level of protection”.**
- **Procedures for RBA in flood control.**

HYDROLOGIC REQUIREMENTS

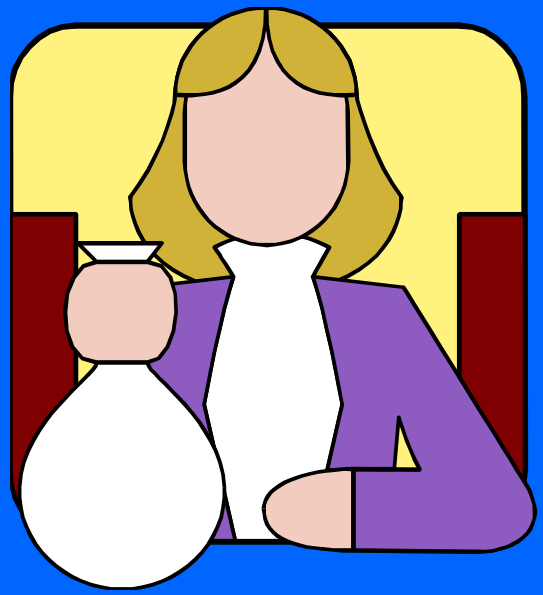
- **Best estimate of discharge-frequency curve**
- **Uncertainty distribution as a function of discharge-exceedence frequency**

HYDRAULIC REQUIREMENTS

- **Best estimates of stage-discharge**
- **Uncertainty distribution as a function of discharge**

ECONOMICS REQUIREMENTS

- **First floor elevation**
- **Structure and content values**
- **Depth-damage curves**



MODEL AVAILABLE

- **NEXT GEN FLOOD DAMAGE ANALYSIS - HEC**

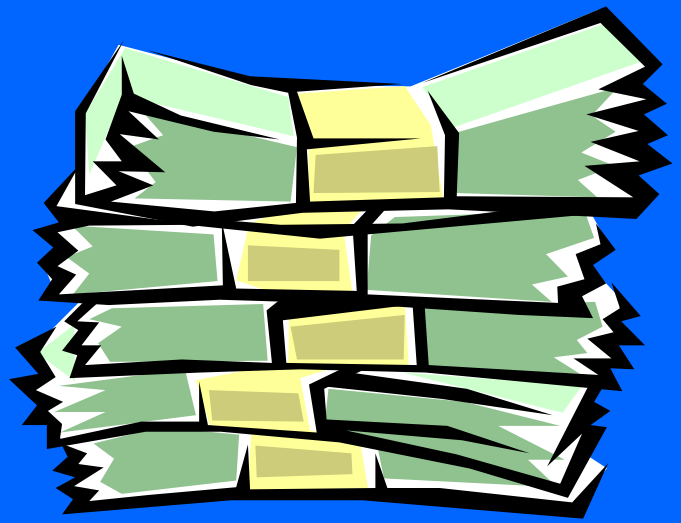
RBA MODEL

- **PROJECT SIZING**
  - Determine expected annual damage (benefits) for any project size with uncertainty.

- **RELIABILITY**
  - Determine percent chance of containing (or risk of overtopping) selected design stages given a specific flood discharge occurs.

NED PLAN

RISK BASED ANALYSIS DOES NOT CHANGE THE REQUIREMENT FOR SELECTING THE NED PLAN.



RBA AND FEMA

- **Guidance dated 10 Apr 97:**
  - Exceptions for projects with commitments
  - Levee certification under NFIP
  - Existing levees, no RBA
  - Existing and proposed levees with RBA